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SPECIAL FEATURES OF THE CHEMICAL AND MINERALOGIC COMPOSITION OF CLAYS FROM THE MAIDAN-VIL'SKOE DEPOSIT

A. M. Digdalovich,[1] M. P. Pona,[1] and Yu. M. Bek[1]

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The chemical and mineralogic composition of clay raw material from the Maidan-Vil'skoe deposit are investigated. The relative instability and regularities of the composition variations in samples taken from different sites and different depths of the quarry are established. Based on the results of correlation analysis, the regression equations and graphic dependences for fast estimation of the content of SiO_2, Al_2O_3, and R_2O in the composition of Maidan-Vil'skoe clay are constructed.

The need for reducing the cost of ceramic tile production hasled to wider application of low-grade low-melting clays. An important problem in this context is the increase in the temperature interval of firing of clay mixtures and the increase in their deformation resistance. One of the methods for solving this problem can be the introduction of kaolinite-containing materials in the mixture compositions. In this context, clays from the promising Maidan-Vil'skoe deposit (Slavustskii district, Khmel'nitskii region) which is at present exploited by the Maidan-Vil'skoe Refractory Works were investigated. These clays have not yet been sufficiently studied and until recently were believed to be unsuitable for the production of ceramic tiles, sanitary ware, and fine ceramics.

The results of the chemical analysis of 20 samples of raw clay material taken from different sites in the quarry and at different depths (Table 1) revealed a lack of stability in the clay composition. The following regularity was discovered: samples from the lower levels of the quarry exhibited a relatively high content of SiO_2 and R_2O, and samples from the

[1] "L'vovskaya Politekhnika" State University, L'vov, Ukraine.

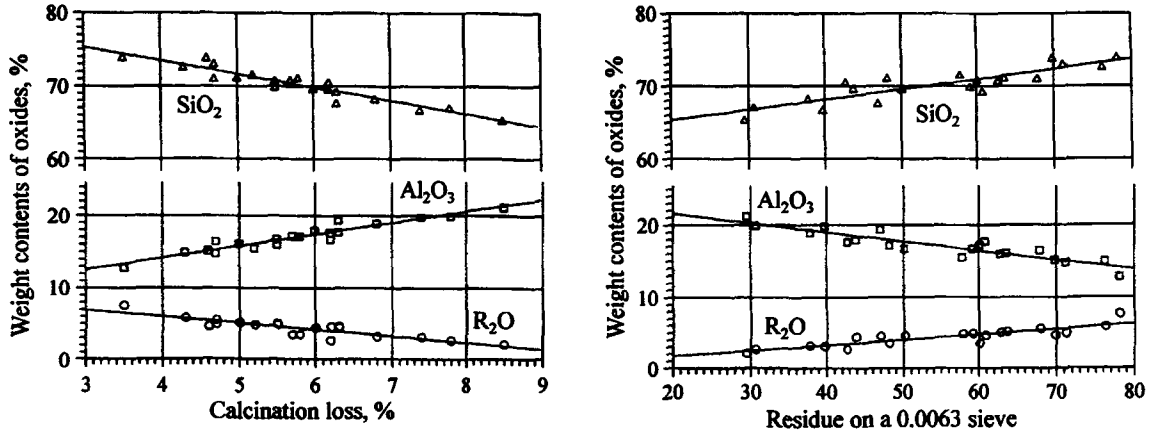

Fig. 1. Dependence of the content of SiO_2, Al_2O_3, and R_2O in the composition of Maidan-Vil'skoe clay on calcination loss and residue on a 0063 sieve.

TABLE 1

Sample	Sampling depth, m	Residue on a 0063 sieve, %	Weight content, %							
			SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	calcination loss
1	1.5	42.7	70.6	17.6	1.0	1.2	0.6	2.2	0.5	6.2
2	4.0	48.1	71.2	17.1	1.0	0.9	0.4	3.1	0.4	5.8
3	2.0	57.8	71.6	15.5	1.0	1.3	0.5	3.4	1.4	5.2
4	5.5	78.1	74.0	12.8	0.7	0.9	0.4	4.1	3.5	3.5
5	2.0	39.8	66.8	19.8	1.0	1.1	0.7	1.7	1.4	7.4
6	4.5	46.9	67.7	19.3	0.8	0.8	0.5	3.3	1.2	6.3
7	2.5	59.1	69.9	16.7	1.0	1.0	0.9	3.6	1.3	5.5
8	5.0	67.9	71.1	16.4	1.0	0.8	0.4	3.8	1.7	4.7
9	1.5	50.1	69.9	16.7	1.0	1.0	0.8	2.9	1.7	6.2
10	5.0	62.8	70.8	16.0	1.1	0.8	0.7	3.7	1.3	5.5
11	2.0	60.8	69.3	17.7	0.9	0.7	0.4	4.0	0.6	6.3
12	5.5	71.2	73.1	14.8	0.9	0.9	0.6	4.4	0.5	4.7
13	2.5	29.5	65.4	21.2	1.2	1.0	0.5	1.8	0.3	8.5
14	4.5	43.8	69.7	17.9	0.8	0.7	0.4	4.0	0.4	6.0
15	3.0	63.6	71.2	16.1	1.0	0.9	0.6	4.3	0.8	5.0
16	8u	76.2	72.7	14.9	0.9	0.8	0.5	4.9	0.9	4.3
17	9d	30.7	67.1	19.9	0.9	0.8	0.7	2.3	0.4	7.8
18	9u	37.9	68.3	18.9	1.0	0.9	0.8	2.6	0.6	6.8
19	10d	60.1	70.9	17.2	0.7	1.1	0.8	2.2	1.3	5.7
20	10u	69.8	73.9	15.1	0.6	0.8	0.4	3.0	1.6	4.6

TABLE 2

X	Y	Correlation coefficient	Equation of linear regression	Rated Fisher coefficient*
Calcination loss	SiO_2	−0.945	$Y = 80.7570 - 1.8124X$	0.592
	Al_2O_3	0.959	$Y = 7.7590 - 1.6071X$	0.442
	R_2O	−0.875	$Y = 9.6508 - 0.9131X$	0.806
Residue on a 00063 sieve	SiO_2	0.876	$Y = 62.5180 - 0.1409X$	3.959
	Al_2O_3	−0.913	$Y = 24.1147 - 0.1282X$	2.165
	R_2O	0.865	$Y = 0.2056 - 0.0757X$	0.790

* The Fisher coefficient in Table 2 for the 5% significance level was equal to 5.8 in all cases.

upper levels exhibited a high content of Al_2O_3 and increased calcination loss.

The x-ray phase analysis established that the clay composition includes kaolinite ($d/n = 0.719$, 0.357, 0.250 nm), quartz (d/n 0.425, 0.333, 0.245 nm), feldspars ($d/n = 0.643$, 0.325, 0.319, 0.291 nm), and the latter are mostly represented by microcline and albite. The weak reflections of 0.993, 0.501, 0.250, and 0.1995 nm point to insignificant amounts of mica impurities (mainly muscovite) and hydromica.

The quantitative calculation of the rock-forming materials which was based based on the data of integrated investigations (x-ray phase analysis, DTA, iodine number) established that the predominant argillaceous material in the Maidan-Vil'skoe clay is kaolinite, whose content varies from 19 to 43%. At the same time, its content tends to increase at the upper levels. Among the nonargillaceous materials, feldspars (18 – 49%) and quartz (18 – 41%) are present. Their highest content was registered at the lower levels of the quarry.

In order to determine the specific dependences in the composition variations of the Maidan-Vil'skoe clay samples, the data in Table 1 were processed using mathematical statistical methods (Table 2). A close linear correlation was found between the content of SiO_2, Al_2O_3, R_2O, the value of calcination losses, and the residue on a 0063 sieve (the correlation coefficients were close to 1). The calculation results were used to obtain regression equations that adequately describe the experimental data at the 5% significance level (the calculated Fisher coefficient was below the value in Table 2).

Based on the correlation analysis results, the dependences were graphically plotted (Fig. 1) allowing fast esimation of the content of the main oxides. It is sufficient to determine the residue on a 0063 sieve or the calcination loss.

The method was tested in industrial production and is successfully used at the Lvov Ceramic Works laboratory for operating control of the chemical composition of the Maidan-Vil'skoe clay. The proposed method is faster and less expensive than chemical analysis.